

LOIC CAPPANERA

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EMPLOYMENT & EDUCATION

Assistant Professor, University of Houston, TX	2019 - Present
Postdoctoral Research Associate, Rice University, Houston, TX	2017 - 2019
Postdoctoral Research Associate, Texas A&M University, College Station, TX	2016 - 2016
Ph.D. Fluid Mechanics, Paris-Saclay University, Orsay, France	2012 - 2015
M.S. Mathematics, Paris-Sud University, Orsay, France	2008 - 2012
French Agregation in Mathematics, ENS Cachan, Cachan, France	2010 - 2011
B.S. Mathematics, Paris-Sud University, Orsay, France	2005 - 2008

GRANTS

NSF DMS-2208046 (\$170,913) <i>Numerical methods for incompressible multiphase flows applied to magnetohydrodynamics.</i>	2022 - 2025
Invited Professor (Missionnaires Invités) at Paris-Saclay University (\$3, 654) <i>Collaborative research on magnetohydrodynamics instabilities in liquid metal batteries.</i>	June 2023

RESEARCH INTERESTS

Finite Element Methods. Incompressible Navier-Stokes equations. Maxwell equations. Level Set Methods. Flows in porous media. PDEs with Nonlocal Diffusive Operator. Applications to Turbulence, Thermal Convection and Magnetohydrodynamics.

BIBLIOGRAPHIC AND SOFTWARE DATABASE

Bibliographic databases.

- [Google Scholar Profile](#)
- [ResearchGate Profile](#)
- ORCID: [0000-0002-3871-1073](https://orcid.org/0000-0002-3871-1073)

Open source MHD-code SFEMaNS.

- <https://github.com/jean-luc-guermond/SFEMaNS>

PUBLICATIONS

24. A. Vu, L. Cappanera, "Error Analysis of a Semi-Implicit Time-Stepping Scheme for Incompressible Flows with Variable Density and Viscosity", submitted
23. S. Benard, W. Herreman, L. Cappanera, C. Nore "Connecting alloy composition to electrical potential in liquid metal batteries", submitted
22. D. Geneste, H. Faller, T. Chaabo, A. Cheminet, V. Valori, Y. Ostovan, L. Cappanera, C. Cuvier , F. Daviaud, J.-M. Foucaut, J.-L. Guermond, J.-P. Laval, C. Nore, V. Padilla, C. Wiertel-Gasquet, B. Dubrulle, "Experimental study of subgrid stresses at the Kolmogorov scale in a turbulent von Kármán flow", submitted
21. G. Jaramillo, L. Cappanera, C. Ward, *Analysis and Simulation of a Nonlocal Gray-Scott model*, accepted in SIAM SIAP (2024).
20. S. Bénard, L. Cappanera, W. Herreman, C. Nore, *Magnetic field based finite element method for magneto-static problems with discontinuous electric potential distributions*, Comptes Rendus. Mécanique, 351.S1 (2023): 1-20, DOI: 10.5802/crmeca.184
19. W. Herreman, L. Wierchalek, G. M. Horstmann, L. Cappanera and C.Nore, *Stability theory for metal pad roll in cylindrical liquid metal batteries*, Journal of Fluid Mechanics, 962 (2023): A6, DOI: <https://doi.org/10.1017/jfm.2023.238>
18. G. Sosa Jones, B. Riviere, L. Cappanera, *Existence and convergence of a discontinuous Galerkin method for the compressible three-phase flow problem in porous media*, IMA Journal of Numerical Analysis (2022) 00, 1–34 , DOI: <https://doi.org/10.1093/imanum/dr ac053>
17. V. Girault, B. Riviere, L. Cappanera, *A Finite element method for degenerate two-phase flow in porous media. Part II: convergence*, Journal of Numerical Mathematics, 29 (2021). DOI: 10.1515/jnma-2020-0005
16. G. Jaramillo, L. Cappanera, C. Ward, *Numerical Methods for a Diffusive Class Nonlocal Operators*, J Sci Comput, 88, 30 (2021), DOI: <https://doi.org/10.1007/s10915-021-01543-7>
15. W. Herreman, C. Nore, L. Cappanera, J.-L. Guermond, *Efficient mixing by swirling electrovortex flows in liquid metal batteries*, Journal of Fluid Mechanics, 915 (2021) A17, DOI: <https://doi.org/10.1017/jfm.2021.79>
14. H. Faller, D. Geneste, T. Chaabo, A. Cheminet, V. Valori, Y. Ostovan, L. Cappanera, Ch. Cuvier, F. Daviaud, J.-M. Foucaut, J.-L. Guermond, J.-Ph. Laval, C. Nore, V. Padilla, C. Wiertel-Gasquet and B. Dubrulle, *On the nature of intermittency in a turbulent von Karman flow*, Journal of Fluid Mechanics, 914 (2021) A2, DOI: <https://doi.org/10.1017/jfm.2020.908>
13. C. Nore, L. Cappanera, J.-L. Guermond, T. Weier, W. Herreman, *Feasibility of metal pad roll instability experiments at room temperature*, Phys. Rev. Lett., 126 (2021), 184501, DOI: <https://doi.org/10.1103/PhysRevLett.126.184501>
12. V. Girault, B. Riviere, L. Cappanera, *A Finite element method for degenerate two-phase flow in porous media. Part I: well-posedness*, Journal of Numerical Mathematics, 29 (2021). DOI: 10.1515/jnma-2020-0004

11. L. Cappanera, P. Debue, H. Faller, D. Kuzzay, E-W. Saw, C. Nore, J.-L. Guermond, F. Daviaud, C. Wiertel-Gasquet, B. Dubrulle, *Turbulence in realistic geometries with moving boundaries: when simulations meet experiments*, Computer & Fluids, 214 (2021): 104750, DOI: 10.1016/j.compfluid.2020.104750
10. W. Herreman, S. Benard, C. Nore, P. Personnettaz, L. Cappanera, J.-L. Guermond, *Solutal buoyancy and electrovortex flow in liquid metal batteries*, Physical Review Fluids, 5 (2020), DOI: 10.1103/PhysRevFluids.5.074501
9. W. Herreman, C. Nore, J.-L. Guermond, L. Cappanera, N. Weber, G. M. Horstmann, *Metal pad roll instability in cylindrical reduction cells*, Journal of Fluid Mechanics, 878 (2019) 598-646, DOI: 10.1017/jfm.2019.642
8. W. Herreman, C. Nore, P. Ziebell Ramos, L. Cappanera, J.-L. Guermond, *Numerical simulation of electro-vortex flows in cylindrical fluid layers and liquid metal batteries*, Physical Review Fluids, 4 (2019), DOI: 10.1103/PhysRevFluids.4.113702
7. L. Cappanera and B. Riviere, *Discontinuous Galerkin method for solving the black oil problem in porous media*, Numer Methods Partial Differential Eq. (2018) 1-29, DOI:10.1002/num.22324
6. C. Nore, D. Castanon Quiroz, L. Cappanera and J.-L. Guermond, *Numerical simulation of the Von-Karman-Sodium experiment*, Journal of Fluid Mechanics, 854, (2018) 164-195, DOI:10.1017/jfm.2018.582
5. L. Cappanera, J.-L. Guermond, W. Herreman, C. Nore, *Momentum based approximation of incompressible multiphase fluid flows*, Int. J. Numer. Meth. Fluids, 86 (2018) 541–563, DOI: 10.1002/fld.4467
4. R. Zanella, C. Nore, F. Bouillault, L. Cappanera, I. Tomas, X. Mininger and J.-L. Guermond, *Study of Magnetoconvection Impact on a Coil Cooling by Ferrofluid with a Spectral / Finite Element Method*, IEEE Transactions on Magnetics, 54:3 (2018) 460014, DOI: 10.1109/TMAG.2017.2749539
3. C. Nore, D. Castanon Quiroz, L. Cappanera and J.-L. Guermond, *Direct numerical simulation of the axial dipolar dynamo in the Von-Karman-Sodium experiment*, Euro. Phys. Letters, 114 (2016) 65002, DOI:10.1209/0295-5075/114/65002
2. L. Cappanera, J.-L. Guermond, J. Léorat , C. Nore, *Two spinning ways for precession dynamo*, Physical Review E, 93 (2016) 043113, L. Cappanera, J.-L. Guermond, J. Léorat, C. Nore, "Two spinning ways for precession dynamo", Physical Review E, 93 (2016) 043113, DOI: 10.1103/physreve.93.043113
1. W. Herreman, C. Nore, L. Cappanera, J.-L. Guermond, *Taylor instability in liquid metal columns and liquid metal batteries*, Journal of Fluid Mechanics, 771 (2015) 79-114, DOI: 10.1017/jfm.2015.159

INVITED TALKS

- 2023** *Numerical methods for incompressible Navier-Stokes equations with variable density.* CMAI Colloquium, George Mason University, Fairfax, VA (10/06/2023).
- 2023** *Pseudo-spectral methods for incompressible two-phase flows with temperature and magnetic effects.* AMS Fall Eastern Sectional Meeting, Buffalo, NY (09/09-10/2023).
- 2023** *Projection and artificial compressibility methods for incompressible flows with variable density.* Numerical analysis and PDEs seminar, Math. Dept. University Paris-Saclay, Orsay, France (06/08/2023).

- 2023** *Numerical methods for incompressible flows with variable density and applications to liquid metal batteries.* Math 2 Prodcut (M2P) conference, Taormina, Sicily, Italy (05/30-06/01/2023).
- 2023** *Numerical methods for multiphase flows with discontinuous electric potential distributions.* AMS Spring Central Meeting Section, Cincinnati, OH (04/15-16/2023).
- 2023** *Efficient numerical methods for incompressible multiphase flows and applications to magnetohydrodynamics.* Scientific Computing Seminar, Math. Dpt. University of Houston, Houston, TX (04/06/2023).
- 2023** *Pseudo-spectral methods for incompressible flows with variable density.* Applied Mathematics Seminar, Math. Dpt. Texas Tech University (online, 03/28/2023).
- 2023** *Robust and efficient numerical methods for incompressible flows with variable density.* Colloquium, Math. Dept Oakland University, Rochester, MI (03/14/2023).
- 2022** *Robust numerical methods for incompressible flows with variable density.* Numerical Analysis seminar, Math. Dept. TAMU, College Station, TX (09/28/2022).
- 2022** *Artificial compressibility and splitting methods for the incompressible Navier-Stokes equations with variable density.* AMS Fall Central Meeting Section, El Paso, TX (09/17/2022).
- 2022** *Artificial compressibility and projection methods for incompressible multiphase flows.* 6th Coastal Bend Mathematics & Statistics Conference CBMSC (online, 04/09/2022).
- 2021** *Discontinuous Galerkin method for black oil problem: convergence and applications.* SIAM SEAS 2021, Auburn University, Auburn, AL (online, 09/18-19/2021).
- 2021** *Discontinuous Galerkin discretization of the three-component three-phase flow problem.* WCCM-ECCOMAS Congress (online, 01/11-15/2021).
- 2020** *Momentum based approximation of incompressible flows with variable density and viscosity.* 3rd SIAM TX-LA Annual Meeting (online, 10/18/2020).
- 2020** *Momentum based approximation of incompressible flows with variable density and viscosity. Application to magnetohydrodynamics.* AMS Fall Central Meeting (online, 09/12/2020).
- 2020** (symposium/talk canceled due to pandemic) *Momentum based approximation of multiphase flows and magnetohydrodynamics problems.* SIAM Annual Meeting.
- 2019** *Flexible Discretizations of the Three-component Three-phase Flow Problem.* SPE Reservoir Simulation Conference Galveston, TX (04/10/2019).
- 2019** *Discontinuous Galerkin method for solving the black oil problem in porous media.* SIAM Conference on Mathematical & Computational Issues in the Geosciences (GS19), Houston, TX (03/14/2019).
- 2018** *Nonlinear stabilization of the magnetohydrodynamics equations. Applications to multiphase flow.* Scientific Computing Seminar, University of Houston, Houston, TX (10/04/2018).
- 2017** *Nonlinear stabilization of magnetohydrodynamics equations. Applications to multiphase flow.* CAAM Colloquium, Rice University, Houston, TX (11/09/2017).
- 2017** *Momentum based approximation of incompressible multiphase flows and applications to metal pad roll instability.* International Symposium on Bifurcations and Instabilities in Fluid Dynamics (BIFD), The Woodlands, TX (07/11-14/2017).

- 2015** *Momentum based approximations of incompressible multiphase flows* Bifurcations and Instabilities in Fluid Dynamics (BIFD), Paris, France (07/15/2015).
- 2014** *Multiphase flow computations with SFEMaNS-MHD code.* European GDR Dynamo, Cambridge, England (09/01-04/2014).

CONTRIBUTED TALKS

- 2024** *Numerical methods for immiscible incompressible multiphase flows with thermal convection.* WCCM-PANACM, Vancouver, Canada (07/21-26/2024).
- 2024** *Analysis and numerical simulations of a nonlocal Gray-Scott model.* Finite Element Rodeo, Rice University, Houston (03/08-09/2024).
- 2023** *Discontinuous Galerkin method for three-phase flows in porous media.* USNCCM 17, Albuquerque, NM (07/23-27/2023).
- 2023** *Finite element methods for magneto-static problems with discontinuous electric potential distribution.* Finite element Rodeo, TAMU, College Station, TX (03/24/25/2023).
- 2023** (canceled due to visa issue) *Robust numerical methods for the incompressible Navier-Stokes equations with variable density.* SIAM CSE, Amsterdam, Netherlands (02/26/2023-03/03/2023)
- 2022** *Pseudo-spectral methods for the incompressible magnetohydrodynamics equations with variable density.* 5th SIAM TX-LA Annual Meeting, Houston, TX (11/04-06/2022).
- 2022** *Projection and artificial compression methods for incompressible multiphase flows.* Finite Element Rodeo, Southern Methodist University, Dallas, TX (03/04-05/2022).
- 2021** *Projection and artificial compression methods for incompressible multiphase flows.* 4th SIAM TX-LA Annual Meeting, UTRGV, South Padre Island, TX (11/05-07/2021).
- 2018** *Discontinuous Galerkin method for solving the black oil problem in porous media.* Finite Element Circus, University of Delaware, Newark, DE (11/09-10/2018).
- 2018** *Approximation of porous media flow. Black Oil Model.* Finite Element Rodeo, Louisiana State University, Baton-Rouge, LA (02/23-24/2018).
- 2016** *Momentum based approximation of incompressible multiphase flow.* Finite Element Rodeo, College Station, TX (03/04-05/2016).
- 2015** *Momentum based approximation of incompressible multiphase flows with SFEMaNS MHD-code.* Journée de Dynamique des Fluides du Plateau d'Orsay (JDFP), Orsay, France (03/24/2015).
- 2014** *Multiphase flow computations with SFEMaNS-MHD code.* Journée de Dynamique des Fluides du Plateau d'Orsay (JDFP), Orsay, France (02/11/2014).

POSTER

2015 *Momentum-based approximation of incompressible multiphase fluid flows.* Rencontre du Non Linéaire (RNL), Paris, France (03/2015).

2014 *Multiphase flow computations with SFEMaNS-MHD code.* Colloque Alain Bouyssy, Orsay, France (02/2014). Awarded with Best Poster.

MENTORING

Postdoctoral Research Associate

- Giselle Sosa Jones (Fall 2020-Summer 2022)
Topics: Discontinuous Galerkin finite element methods for multiphase flows in highly heterogeneous media.
Current position: Assistant Professor, Department of Mathematics and Statistics, Oakland University, Rochester, MI.

Graduate Students

- Salvatore Giordano (Fall 2023-present)
Topics: Artificial compressibility techniques for incompressible Navier-Stokes equations with variable density.
- Mark Simmons (Fall 2023-present)
Topics: High-order Discontinuous Galerkin finite element methods for flows in porous media with mass transfer effect.
- An Vu (Fall 2021-Summer 2024)
Topics: Projection methods for incompressible Navier-Stokes equations with variable density and turbulent thermal convection.
Expected Graduation: Summer 2024 (defense on May 15, 2024)
Future position: Assistant Professor, Department of Mathematics, University of St. Thomas, Houston, TX (starting date: Fall 2024).

Master Students

- Taylor Ennadi (Fall 2024-Spring 2025).
Topics: Finite Element Methods for incompressible multiphase flows and applications to turbulent thermal convection.

Undergraduate Students

- Walker Bordovsky (Fall 2024)
Topics: Introduction to Finite Element methods and applications to computational fluid dynamics..
- (Quoc Nguyen (Summer 2022, ~4 weeks)
Topics: Introduction to Finite Element methods and FreeFEM++ software.
Current position: Graduate Student, Department of Mathematics, University of Houston.

TEACHING EXPERIENCE

University of Houston

MATH 6371: Numerical Analysis II	Sp-2024
MATH 2318: Linear Algebra	Sp-2024, Fa-2022
MATH 6370: Numerical Analysis I	Fa-2023
MATH 4364: Intro to Numerical Analysis in Scientific Computing	Sp-2023
MATH 3363: Intro to PDEs	Fa-2022, Sp-2022, Fa-2020
MATH 4335: Partial Diff Equations I	Fa-2021
MATH 4377-6308: Advanced Linear Algebra I	Sp-2021
MATH 1451: Accelerated Calculus II	Sp-2020
MATH 1450: Accelerated Calculus I	Fa-2019

Rice University

CAAM 519: Computational Science I	Fa-2018, Fa-2017
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IUT Paris-Saclay University

General Mathematics (Calculus, ODEs)	Sp-2015, Sp-2014, Fa-2012
Computer Science (Excel, PowerPoint, Statistics)	Sp-2015, Sp-2014, Fa-2012
Graph Theory	Sp-2014

SERVICE

University of Houston Committees:

- Scientific Computing Seminar Committee, Fall 2023 - present.
- Graduate Studies Committee, Fall 2022 - present.
- Colloquium Committee, Spring 2021 - present (Committee Chair starting Summer 2024).
- Numerical Analysis Hiring Committee (open rank), Fall 2023 - Spring 2024.

PhD Thesis Committees:

- 2024** An Vu (adviser: Loïc Cappanera)
- 2023** Manoj Subedi (adviser: Krešimir Josić)
- 2022** Thuyen Dang (adviser: Yuliya Gorb)

Organization of Conferences:

- 2022** Member of the local organizing committee (chair: William Ott) of the [5th SIAM TX-LA Annual Meeting](#), Houston TX, 11/04-06/2022.

Organization of Minisymposia & Workshops:

- 2024** Co-organizer (w/ Keegan Kirk and Giselle Sosa Jones) of WCCM minisymposium, *Recent Advances in discretization techniques for Coupled Problems in Incompressible Fluid Dynamics*, [WCCM-PANACM 2024](#), Vancouver, Canada, 07/21-26/2024.

- 2023** Co-organizer (w/ Tamas Horvath and Giselle Sosa Jones) of USNCCM minisymposium, *Recent Advances in FE Methods for Coupled Problems in Incompressible Fluid Dynamics*, **USNCCM 17**, Albuquerque NM, 07/23-27/2023.
- 2023** Co-organizer (w/ Tamas Horvath) of SIAM minisymposium, *Robust finite element methods for convection-diffusion problems*, **SIAM CSE 23**, Amsterdam, Netherlands, 02/26-/2023 03/03/2023
- 2022** Co-organizer (w/ Giselle Sosa Jones) of SIAM minisymposium, *Numerical methods and applications for geosciences*, **5th SIAM TX-LA Annual Meeting**, Houston TX, 11/04-06/2022.
- 2021** Organizer of SIAM minisymposium, *Numerical methods for multi-phase flows in porous media*, **4th SIAM TX-LA Annual Meeting**, University of Texas Rio Grande Valley, South Padre Island, TX, 11/05-07/2021.

Reviewer for Journals:

- **AMS** - MathSciNet
- **CAMWA** - Computers & Mathematics with Applications
- **CMAM** - Computational Methods in Applied Mathematics
- **CMAME** - Computer Methods in Applied Mechanics and Engineering
- **JMAA** - Journal of Mathematical Analysis and Applications
- **JOMP** - Springer Journal of Scientific Computing
- **MCOM** - AMS Mathematics of Computation
- **NACO** - Numerical Algebra, Control and Optimization
- **NMPDE** - Numerical Methods for Partial Differential Equations
- **SISC** - SIAM Journal on Scientific Computing
- **Springer Nature** - Nature Physics